A syntactical understanding of Valencia's growth and metropolitan interactions in the second half of the 20th century

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Abstract: Valencia's urban evolution has been often analyzed through its longstanding relation to the Turia River and its expansion towards the Mediterranean Sea, which are the main organizational spatial features of the city. In this article, Space Syntax theory has been used to further understand the underlying structure of the city's growth between 1944 and 2000, contrasting it with a historical reflection that provides a solid basis for the scientific data retrieved. We have found an interesting evolution of the urban structure, which is characterized by an increasing connectivity of the street network and the consolidation of the agricultural system that defines the metropolitan area. This correlation illustrates the structural evolution of the city as a conglomeration of smaller-scale systems that support the spatial configuration of its network. Together with the bigger picture of Valencia's relation to the sea and the river, the understanding of these aggregations, which have their origins in suburban villages that were adhered to Valencia's body as it expanded over time, becomes a priority for laying future urban planning schemes.

Introduction: an analytical approach to Valencia's morphological evolution

Valencia is the name of both the city analyzed in this article and of the province where it is located. It is the capital of the Valencian Community, and today corresponds to the third most populated city of Spain. The number of inhabitants was 750.476[1] by the year 2001, which triplicated the 213.550 census from the beginning of the 20th century. The area still conserves certain urban features from the Roman and Moor periods, such as the irrigation systems and agricultural traditions (Coscollá, 2003). These activities occupy now a total of 4.000 hectares in the whole province despite that by the year 2000 only engaged around 2% of the active population,[2] a socio-spatial contrast that still now highly influences the underlying structure of the city.

The urban area is divided into districts and neighborhoods, most of which were independent municipalities until the beginning of the previous century. It presents a radial structure with several concentric ring roads and spokes that connect the city with the hinterlands. The metropolitan area is composed by a dense net of municipalities, which in several areas form a continuum with the conurbation of the city. A considerable number of these municipalities—such as Torrent, Paterna or Mislata—already reached a population of over 40.000 inhabitants by the beginning of the 21st Century.

When analyzing the morphological evolution of Valencia through its modern history, each previous study has chosen a different parameter from which to explain this city's urban changes. Among these studies, we can find the ones that focus on Valencia's strong relationship to the Turia River and the Mediterranean Sea (Sorribes, 2010); some others that analyze the expansion principally based on economic factors (Simó, 2004); and finally those which justify the generation of the conurban network as a consequence of the lack of employment resources of the capital (Salom et al., 1995). However, most of these studies do not delve into the significant role that the tightly-packed peri-urban structure has played and continues to play in organizing the ongoing urban enlargement processes.

In this article, we put forward another parameter of analysis—the spatial configuration of the city—applying Space Syntax techniques (Hillier et al., 1989). The results suggest that Valencia is not an individual entity but the cooperative sum of many others that still keep part of their original structure. On this subject, apart from our previous paper on the pedestrianization impact on the city global urban dynamics (Laguía and Moya, 2017), there are other authors who have used Space Syntax to study Spanish cities. For example, Arnaiz, Ruiz-Apilánez and Ureña have already used Space Syntax theories for the study of several cities in order to explain how the accessibility pattern of urban spatial networks evolves and changes through time as the city grows (Arnaiz et al., 2013). In this research, a similar approach has been applied to the particular case of Valencia and its metropolitan area to complement the existing analysis of this city's morphological history.

In the following section, we present a review of some previous studies of Valencia. Then, we detail the methodology which has been used to complement the Space Syntax Analysis. Afterwards, we introduce the specific analysis of the history of the urban form of Valencia from 1944 to 2000. Finally, in a closing section, we summarize the relevance of these 50 years of the urban fabric's evolution, concluding that a deeper understanding of the metropolitan area is undoubtedly helpful for the future planning of the city.

Valencia and the PGOUs:[3] a brief history of Valencia's growth and planning

During the first half of the 20th century, Valencia witnessed one of the strongest immigration episodes of the whole country, violently taking over the plantation lands and transforming its agricultural setback of irrigation canals into one of the most influential Spanish urban metropolis. During that period, encouraged by hygienist measures, similar to the ones that were being implemented in other European cities, the

growing settlements started to be connected through avenues and transit axes. Several ring roads and bypasses were planned, entangling with the expanding metropolitan area of Valencia.

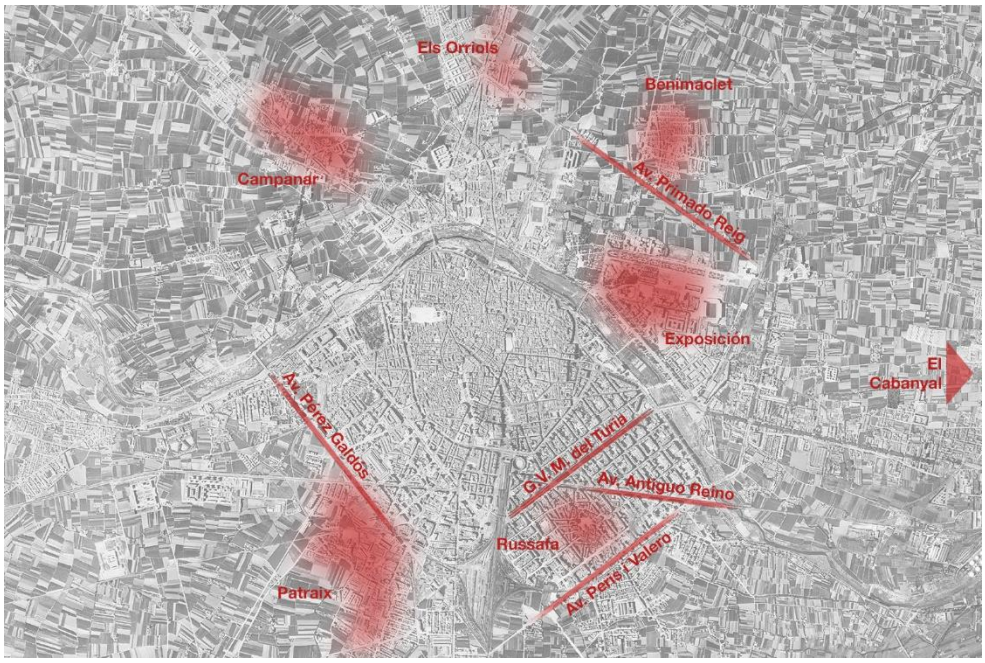

Fig. 01. Photogrammetric aerial view of Valencia around 1955-56 Source: PNOA Histórico, Vuelo Americano Serie B, 1955-1956.

Afterwards, the 1946 PGOU was implemented in an undeclared attempt to anticipate the very strong population growth that was going to occur during Francisco Franco's dictatorship. This PGOU was the first document containing territorial management criteria beyond the usual tools that had been employed so far—namely, expansion plans and operations of internal renovation (Sánchez, 2013). Largely, the measures fostered by the plan were based on a polycentric rural-urban model with vast agricultural surfaces between the existing residential areas of Benimaclet, Els Orriols, Campanar, Patraix, Russafa, and some others (figure 1). In words of the plan's authors, Valencia had to consolidate its central core surrounded by a ring of independent units (Añón, 2010). Thus, in order to limit the growth, the city had to be circumscribed by green belts and the whole system had to be structured by a radial and concentric street network.

In line with the Garden City theories which were being applied in the UK, the PGOU proposed a certain degree of independence between the districts, and a non-hierarchical concept of centrality based on autonomous facilities evenly distributed over the territory. It was easy to do so in Valencia thanks to the presence of the aforementioned rural settlements, which did not demand starting from scratch. Nevertheless, the unpredicted events that took place during the next decades forced to design a new plan in 1966 that adopted a much different character in comparison to the 1946 plan. These events were, first, the Turia River flood in 1957, and second, the increase of immigrant population from other regions of Spain, which forced the plan to inevitably consent a rapid city growth. The extensive urbanized areas were not accompanied by the proportional increase of public equipment required for each existing and new neighborhood (Boira, 2002). Besides, unlike the previous plan, this one had evident speculative purposes that facilitated the intervention of the private sector (Sorribes, 2010). Consequently, the process of adaptation of the existing villages to the growing structure of the city ultimately affected many historical urban patterns, and Valencia saw many of its streets filled with repetitive housing blocks.

After the big expansion throughout the 60s and 70s, which took place thanks to the new land use regulations, the first democratic local government started to review the old urban plans due to the strong social demands

and the lack of economic resources. The 1988 Plan recovered the spirit of the 1946 plan and tried to fix limits to Valencia's growth through a committed urbanism, as opposed to the practices of the Franco period (Torreño, 2005). It fostered the construction of many new infrastructures, such as highways and freeways to interconnect Valencia and its surroundings. Additionally, it implemented a politic of public spaces and facilities, such as the Modern Art Museum and the Music Palace. However, as the result of liberal policies and mechanisms implemented during the 90s,[4] the private urbanization agents had the power to decide where and when to build in the city, and the so-called period of democratic transition was one more time convulsed by the speculative "perverse effects of urban success" (Borja et al., 2004). Hence, the 90s and the beginning of the 21st Century became a period in which Valencia lost many of its local particularities in its pursuit of an international identity, being the controversial City of Arts and Science the icon of this transformation (García, 2004).

In conclusion, as Boira (2002) acknowledged, the twentieth century has been characterized by a strong increase in resident population and urbanized areas, bringing about not only the extensive occupation of agricultural lands, but also a social mismatching and polarized differences among neighborhoods, districts and municipalities of the same metropolitan region. To some extent, the RIVA Plan[5] and the designation of many buildings and whole areas as Assets of Cultural Interest[6] helped to stop the programmed deterioration of some of the most distinctive parts of Valencia (Simó, 2004).

In this article, we propose a complementary revision of the current understanding of Valencia's spatial configuration based on a syntactical analysis of its historical evolution. Such analysis intends to contribute to the current academic and planning literature of the city in order to tackle more efficiently present and future urban demands.

Methods: Cartographical adaptation to Space Syntax models

A historical understanding of the city as an evolutionary entity (Marshall, 2009) is necessary for two reasons: first, to envision next stages of its growth, and second, to dissect the successes and errors of each of its past steps. Therefore, we have compiled a set of maps through the cartographical redrawing methodology (Pinho et al., 2009) using vector street maps for the most recent periods and raster orthographic images and scanned historical maps for the earliest years presented in the historical analysis. This analysis allowed us to generate a time series representation of Valencia's street network in four historical moments: 1944, 1970, 1985, and 2000 (figure 2). Disregarding the vector line-based plans produced by the IGN,[7] the use of this precise mechanism has been necessary since the rest of the historical data was available only in raster image format, which cannot be used to analyze urban patterns by means of the Space Syntax techniques, explained in the following paragraphs.

The specific steps employed to compose these maps are as follow. First, starting from an accurate and relatively updated version of the current street network, a full road-center line map has been drawn using Graphic Information Systems (GIS) software. Second, the present situation of the city has been redrawn over the latest orthophoto taken from the PNOA,[8] thus creating the foundation to represent the condition shown by the raster image historical maps, retrieved from the CNIG.[9] Third, starting from the most recent period map, the contemporary vector lines that represent each street in Valencia have been superposed over the raster images, deleting all the lines that do not match with that precise time point and redrawing the preexisting network. And later, as can be observed in figure 3, once the new map for the second newest period was completed, the procedure was repeated for each preceding source.

It is important to mention as well that, from the 1970 period onward, the pedestrian routes created in the old Turia's riverbed, which represent a particular casuistic of Valencia's urban evolution, have been considered in the calculation of the results (figures 5 to 7). However, these routes have been displayed in

grey in the following images to have a clearer visualization of the overall structure in the city (Hillier et al., 2012).[10]

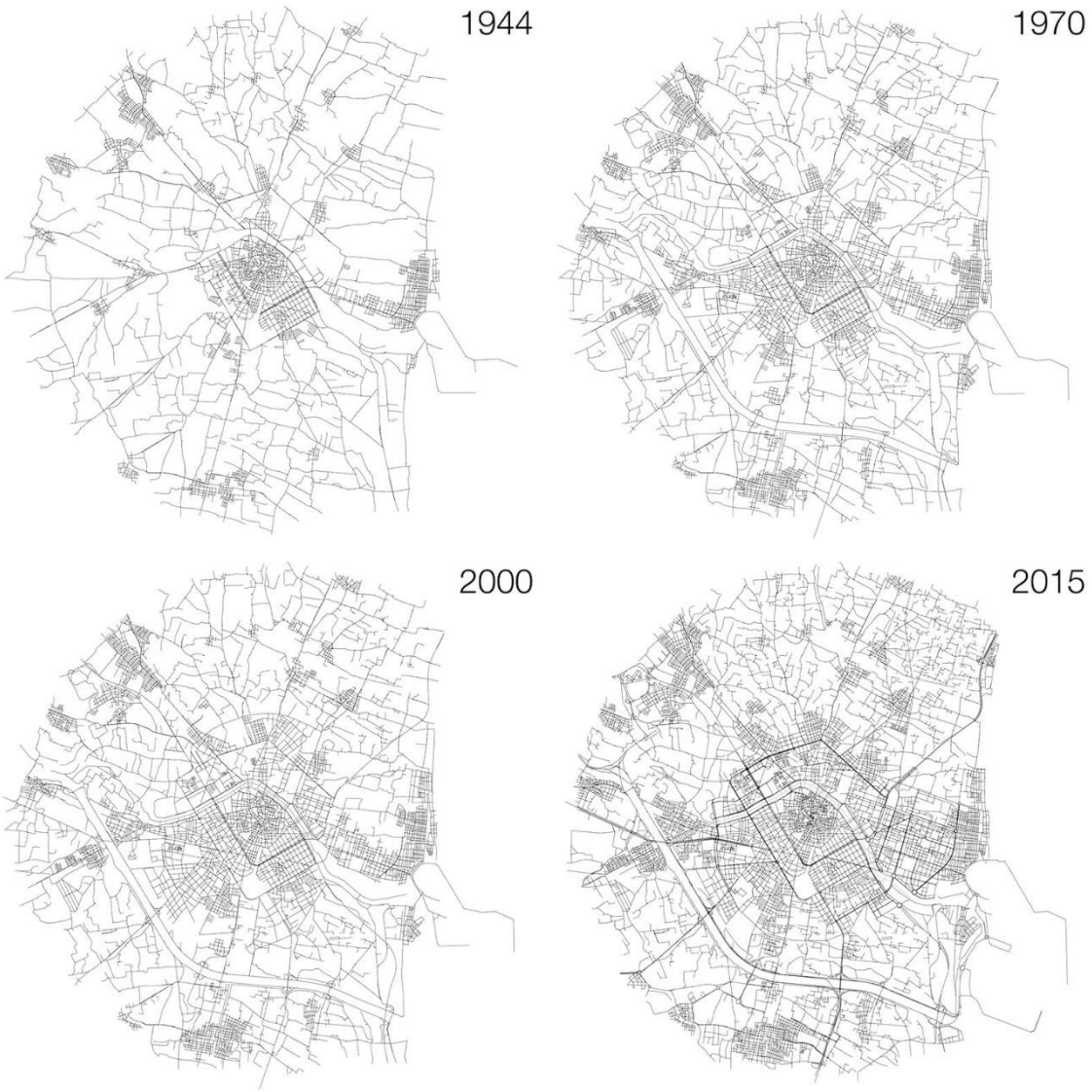

Fig. 02. Valencia's stages of analysis. Source: compiled by authors.

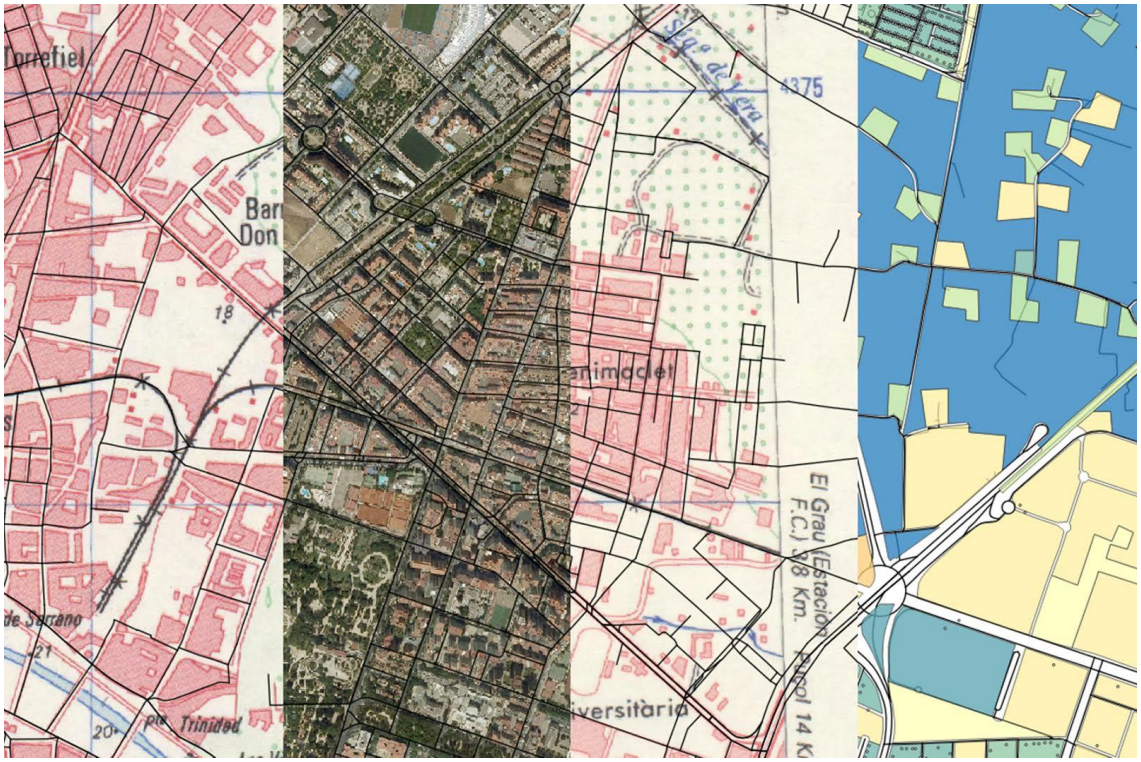

Fig. 03. Cartographical redrawing process in the neighborhood of Benimaclet. Source: compiled by authors.

Afterwards, Space Syntax has been used here since it is today one of the strongest tools for spatial analysis at a city scale.[11] It has allowed us to illustrate in a graphic way a strong correlation between the evolution of the street network of Valencia and the way citizens use public spaces in this city, representing and measuring their characteristics (Kim et al. 2004). The resulting product of this analysis, obtained from the aforementioned historical maps of the urban fabric, is a color gradient map based on numerical representations of the street networks, which renders the spatial configuration of the selected place (Penn, 2003). This is only possible since Space Syntax, in effect, first hypothesizes common dynamics of relationality in terms of their capability to allocate certain social activities, and later translates them into geometric representations of the system of places under examination. In the case of this research, we can see how diverse behavioral patterns are imprinted in the presented layouts. This approach helps to understand why and how Valencia has grown to its current condition, evaluating the potential of its different spatial arrangements and relating them to the historical events that happened in each period under analysis.

For that purpose, the specific tools used in this research are angular segment integration analysis and angular segment length weighted choice analysis to avoid the line length problems derived from road-centered line models (Turner, 2007). These two measures have been proved to approximate in a similar way the potential of the to-movement (integration) and the through-movement (choice) previously measured by the axial maps. Their joint interpretations can correlate, first, the accessibility of a space as destination from other points of the urban grid, and, second, the likelihood of it being part of the route between other different spaces of the system. Therefore, the interface of relation between integration and choice measurements, both at a radius of 600 meters—a ten-minute walk route—and at 3000 meters—taking into account the whole system—are key to understanding the underlying structure and the evolution of the suburban areas of the city. In this regard, as it has been illustrated in previous studies for other cities (Vaughan et al., 2013), the areas where a high integration and a high choice overlap have the potential to become central—or are already—nodes of Valencia's structure and have the highest probability to concentrate urban activity.

Results

In order to explain the confluence of the physical/spatial developments with the social/economic generative forces, we first analyze the particular historical events that gave birth to each urban transformation from the point of view of the urban matrix. Later, the consequences of the urban alterations are taken into account from the perspective of their influence on the social scenario. As it has been introduced in the methods chapter, we discuss the evolution of the results of the measurements at radius 3000 meters and at radius 600 meters. The analysis for choice and integration measures at the two radii are displayed jointly for each of the four periods. Then, after each set of images, both measures are discussed together since their correlation is key to describing the street network movement.

The top set of maps in figure 4 displays the values at radius 3000 meters for the year 1944, prior to the Turia River flood. First, the expansion of the integration area towards the south is noticeable. It assumes successfully the recently consolidated expansion plan[12] in the two measures analyzed. Second, the streets on both sides of the river start to play already a preponderant role. These rapid transit streets complemented the distant transit beltways Avenida Primado Reig and Avenida Pérez Galdós, which were designed during the first decades of the 20th century so as to link Valencia to its metropolitan area. Along with these premature spokes, the planning of a secondary net of roads connecting the satellite agricultural settlements is also significant, thus acknowledging the role that these are playing for the stability of Valencia itself and conforming an early deformed wheel (Hillier, 1989). With regard to the local choice values, we can see the same tendency towards the south, where the city, blocked by the river on the north, first developed its urban expansions. However, the high integration—at both scales—is not matched with a comparable success of the expansion plan network for choice at a 600-meter scale. This contrast blurs the efficiency of the square grid and weakens the organizational capabilities of the Avenida Antiguo Reino de Valencia and the Gran Vía Marqués del Turia.

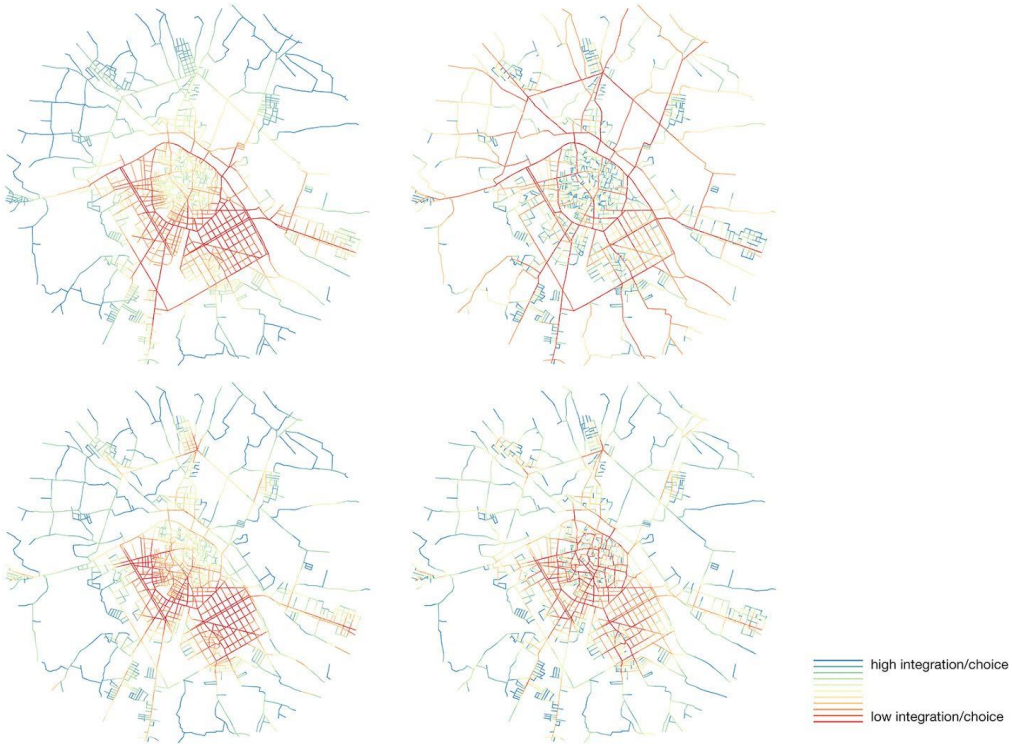

Fig. 04. Valencia 1944. Analysis graphs: 3000 m radius integration (top-left); 3000 m radius choice (top-right); 600 m integration (bottom-left); 600 m choice (bottom-right). Source: compiled by author.

In this set of images for the year 1970 (figure 5), Valencia has conquered and surpassed the distant boundary that once seemed Avenida Pérez Galdós. Additionally, the structure that was planned following the regime established by the PGOU of 1946 has settled. Looking at the 3000-meter radius integration and choice maps, the link designed to join Peris i Valero with Avenida de Giorgeta over the tracks of the train station generates an improved vehicular connectivity in the southern region. However, when paying attention to the overall development over the four images, another two major events of much more relevance also took place in the meantime. On the one hand, a social factor—the population increase due to the immigration phase in the 60s—required allocating the new inhabitants, thus expanding the whole urban grid towards the still independent northern municipalities of Benimaclet, Orriols and Campanar. On the other hand, a spatial factor—the deviation to the south of the Turia's riverbed after the 1957 flood—noticeably altered the spatial network and road connections. These results also corroborate Valencia's expansion towards the Mediterranean Sea, which in 1944 still was a rural route to the maritime towns only flanked by a few rural constructions and has already become, in this period, a main axis of the city. Consequently, the urban structure of the Exposición neighborhood, developed around the buildings of the 1909 Regional Exhibition, is finally consolidated.

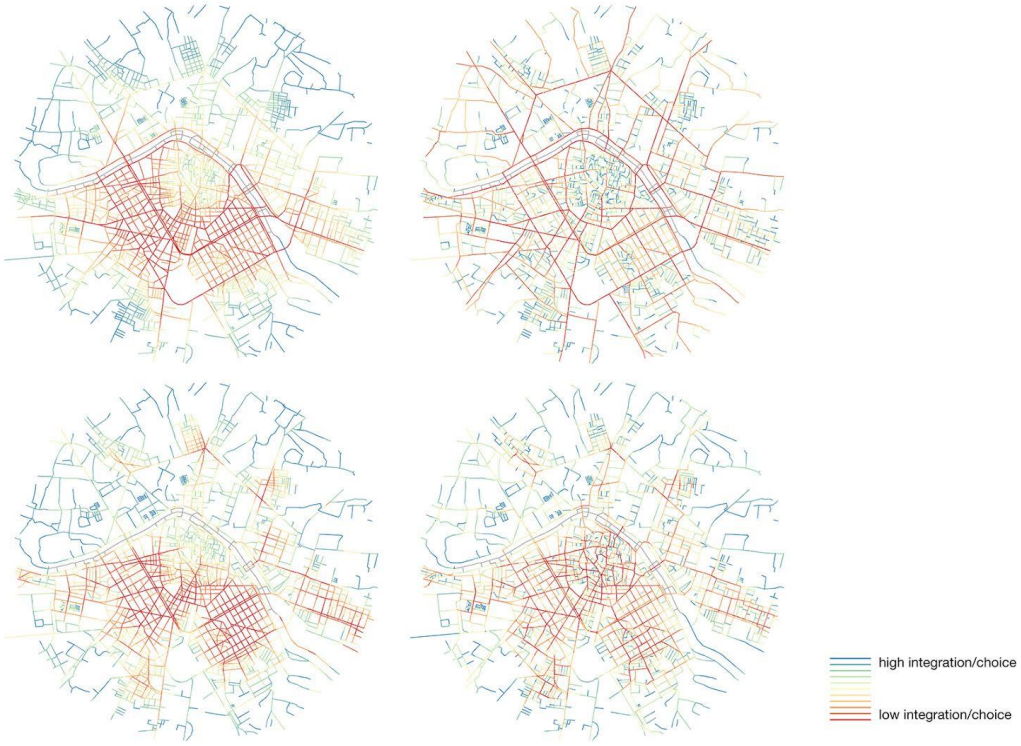

Fig. 05. Valencia 1970. Analysis graphs: 3000 m radius integration (top-left); 3000 m radius choice (top-right); 600 m integration (bottom-left); 600 m choice (bottom-right). Source: compiled by author.

Fifteen years later, Valencia faced the most determinative period of infrastructure development. During these two decades, as it has been mentioned in the previous section, new institutions and social facilities were constructed, and further political-administrative measures were enacted. An important event with consequences in the spatial realm was the adhesion of several of the villages—like Benimaclet in the north of Valencia—to become part as neighborhoods of the city (figure 6). This step not only confirmed the incipient role that those entities were playing in the city, but also helped the merge and blend of the previously independent structures, since several barriers such as train lines were demolished and other connection tools such as the tram system were enabled. Besides, Valencia's expansion to the west configured new urban areas that finally commenced to fill up the spaces between the city and the outer road ring. And at the same time, the eastern roads connecting the city to El Cabanyal became denser and much more

consistent both as structural axes and as strong local spatial arrangements identified by the 600-meter integration analysis.

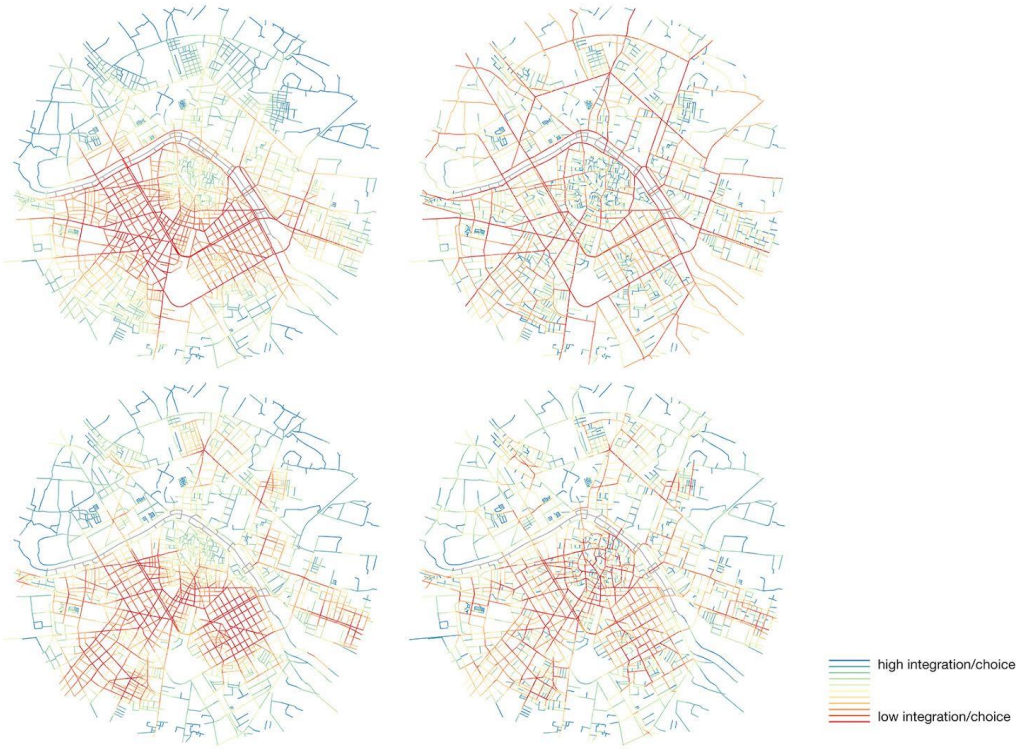

Fig. 06. Valencia 1985. Analysis graphs: 3000 m radius integration (top-left); 3000 m radius choice (top-right); 600 m integration (bottom-left); 600 m choice (bottom-right). Source: compiled by author.

In the year 2000 (figure 7), the concluding phase of these analysis, we can see a further step of the trends taking place over Valencia during the previous 60 years. First of all, we can identify a mature choice network at a 3000-meter scale of analysis, reflecting the still-unconsolidated presence of the Avenida Blasco Ibáñez—yet not strong in previous three maps. Looking at the integration map at radius 3000 meters, we identify a consolidation of the northern-east area above the dried riverbed of the Turia River. Conversely, this consolidation points out the lack of a grid on the western area, where the strong choice values do not match with an equal integration scheme. In addition, in the two lower images, in relation to the observations made along the previous periods dissected, a secondary structure of nodes pervades at the 600-meter scale. The centers of these clusters are the former settlements and villages that have been incorporated to the city as it expanded its urban area. This structure becomes consolidated in the northern area, which development has been followed throughout this article, and in the southern area, in neighborhoods such as Russafa or Patraix. These places have emerged with a strong integration value in the overall structure of the city, and, although they have lost their interstitial agricultural lands along the way—in many cases, by means of the PAIs' standards application—they have kept a strong local identity.

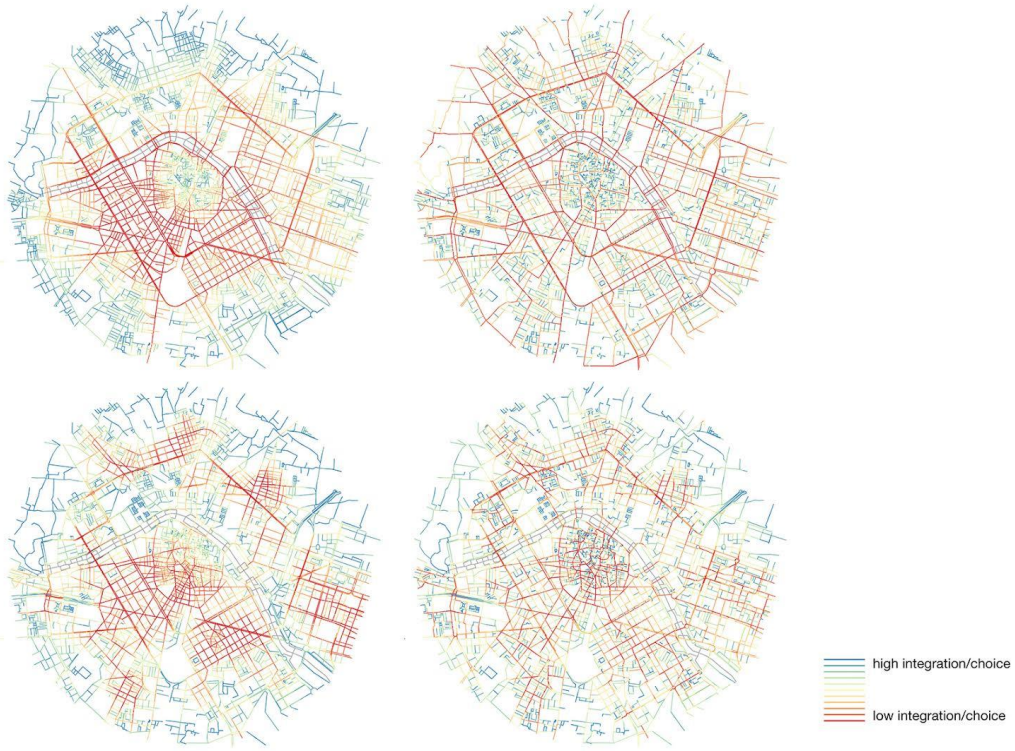

Fig. 07. Valencia 2000. Analysis graphs: 3000 m radius integration (top-left); 3000 m radius choice (top-right); 600 m integration (bottom-left); 600 m choice (bottom-right). Source: compiled by author.

Conclusions: acknowledging Valencia's dual scale

As we have seen along this article, Valencia's metropolitan area has not grown only from the expansion of its historical core, but also as the result of the consolidation of several existing areas, which became integrated to compound today's single entity. "Valencia" is the name that etymologically has prevailed through history, making now its citizens feel and understand the city as an indissoluble whole, but still allowing them to read on a smaller scale the villages and neighborhoods that were absorbed by the larger urban form. Only during the second half of the 20th century, a great diversity of events has shaped the spatial configuration of the city to become the plural body that it is nowadays. For that reason, in line with recent research suggesting cities' pervasive centrality nature (Hillier, 2009), it is important to make further efforts to better understand the complex organizational patterns of Valencia, as well as why some forms have historically been more sustainable than others in this or other cities.

In Valencia and its metropolitan area, regarding the consequences of the urban development during the last decade of the 20th Century, it becomes interesting to bring up the citation of Carl Linnaeus, who remembers that "Without a name the knowledge of an object is lost". The contemporary result of Valencia's urban layout claims to recognize the potential of the smaller settlements such as Benimaclet or El Cabanyal, which, tested through time, have grown into some of the most thriving neighborhoods of the city. This research has highlighted the importance of the spatial configuration and dual scale interactions of certain historical areas in Valencia and has contributed to understand their evolution, pointing out the necessity of acknowledging that the urban structure must be assessed as a system of complex spatial relationships.

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[2] Data retrieved from the Ayuntamiento de Valencia, Oficina de Estadística. Available online at: http://www.valencia.es/ayuntamiento/estadistica.nsf/

[3] PGOU stands for *Plan General de Ordenación Urbana* –*General Urban Development Plan* in English–. It is the first and basic territory planning tool defined by the Spanish law. It classifies the land uses, the regime applicable to each class and defines the fundamental elements of the facilities system for the municipality or set of municipalities studied.

[4] The so called *Planes de Actuación Integrada* (*Integrated Action Plans* in English) introduced the role of the urban agents –not necessarily the owners of the plots– to manage an urbanization process of a terrain.

[5] The RIVA plan was launched in 1992 by the region government with the support of the city council to revitalize the historic center and keep the population living in it as well as to attract new inhabitants.

[6] An Asset of Cultural Interest –BIC, for its acronym in Spanish: *Bien de Interés Cultural*– is a legal concept by which buildings or properties of a region or city are protected so as to preserve the cultural identity of a place or community.

[7] IGN stands for *Instituto Geográfico Nacional*, which means *National Geographic Institute* in English. It is an agency dependent on the Spanish Ministry of Public Works in charge of mapping the totality of the national territory together with *Centro Nacional de Información Geográfica* (see note 7).

[8] PNOA stands for *Plan Nacional de Ortofotografía Aérea*, a project which main objective is the photogrammetric mapping of the whole national territory. It can be found at from http://pnoa.ign.es.

[9] CNIG are the initials of *Centro Nacional de Información Geográfica* –*National Center of Geographic Information* in English–, an independent organization conducting marketing and commercial work for the National Geographic Institute so as to distribute their cartographic publications.

[10] For more information on these representational problems of Depthmap and if in need of a justification for the grey display of the Turia's riverbed routes, please refer to the "Appendix 1: a note on problems", found in Hillier et al. (2012).

[11] Although some authors point out that Space Syntax presents certain methodological handicaps (Batty, 2013) and disregards the three-dimensional influence of space in people's cognition (Ratti, 2003), the handicaps pointed out do not affect the conclusions withdrawn in this research.

[12] Valencia's second expansion plan, which includes the area between Gran Vía Marqués del Turia and Avenida Antiguo Reino, was designed and constructed mostly during the 30s.